

CLAIMS

What is claimed is:

1. A negative electrode for a lithium secondary battery comprising:
a substrate having a mean roughness of 30 to 4000 Å; and
a lithium layer coated on the substrate.
2. The negative electrode for the lithium secondary battery according to claim 1,
wherein the mean roughness of the substrate is 30 to 3000 Å.
3. The negative electrode for the lithium secondary battery according to claim 2,
wherein the mean roughness of the substrate is 30 to 1500 Å.
4. The negative electrode for the lithium secondary battery according to claim 3,
wherein the mean roughness of the substrate is 30 to 500 Å.
5. The negative electrode for the lithium secondary battery according to claim 4,
wherein the mean roughness of the substrate is 30 to 100 Å.
6. The negative electrode for the lithium secondary battery according to claim 1,
wherein the substrate for the negative electrode consists of a conductive material.
7. The negative electrode for the lithium secondary battery according to claim 1,
wherein the substrate is selected from the group consisting of a metal foil, a metal film, a
conductive polymer film, a polymer film deposited with metal, and a polymer film incorporated
with a conductive agent.
8. The negative electrode for the lithium secondary battery according to claim 7,
wherein the metal is copper or nickel.
9. The negative electrode for the lithium secondary battery according to claim 7,
wherein the conductive polymer film is at least one selected from the group consisting of
polyacetylene, polypyrrole, polyaniline, polythiophene, poly(p-phenylene), poly(phenylene
vinylene), polyazulene, polyperinaphthalene, polyacene, and polynaphthalene-2,6-diyl.

10. The negative electrode for the lithium secondary battery according to claim 7, wherein the polymer film deposited with metal is a polymer film on which a metal is deposited, and wherein the polymer film is at least one selected from the group consisting of polyester, polyolefin, polyamide, polycarbonate, polyacrylate, and a copolymer or a mixture thereof.

11. The negative electrode for the lithium secondary battery according to claim 7, wherein the polymer film incorporated with the conductive agent is a polymer film having a conductive agent dispersed therein, and wherein the polymer film is at least one selected from the group consisting of polyester, polyolefin, polyamide, polycarbonate, polyacrylate, and a copolymer or a mixture thereof.

12. The negative electrode for the lithium secondary battery according to claim 11, wherein the conductive agent is selected from the group consisting of a conductive metal oxide, a metal, and a carbonaceous material.

13. The negative electrode for the lithium secondary battery according to claim 12, wherein the conductive agent is selected from the group consisting of tin oxide, tin phosphate (SnPO_4), titanium oxide, a perovskite material, tin, copper, nickel, graphite, and carbon black.

14. The negative electrode for the lithium secondary battery according to claim 7, wherein the mean roughness of polymer film deposited with metal is 30 to 3500 Å.

15. The negative electrode for the lithium secondary battery according to claim 14, wherein the mean roughness of polymer film deposited with metal is 30 to 3000 Å.

16. The negative electrode for the lithium secondary battery according to claim 15, wherein the mean roughness of the polymer film deposited with metal is 30 to 1500 Å.

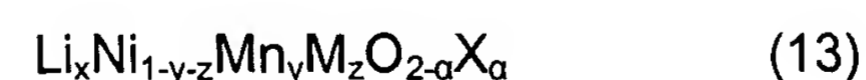
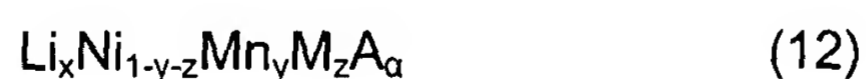
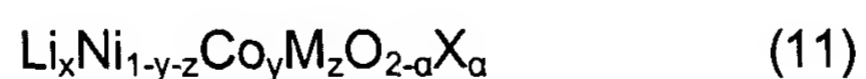
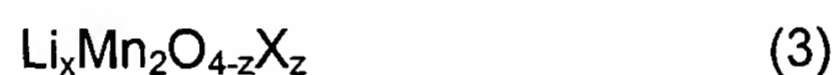
17. The negative electrode for the lithium secondary battery according to claim 16, wherein the mean roughness of the polymer film deposited with metal is 30 to 500 Å.

18. The negative electrode for the lithium secondary battery according to claim 17, wherein the mean roughness of the polymer film deposited with metal is 30 to 100 Å.

19. The negative electrode for the lithium secondary battery according to claim 1, wherein the lithium layer is prepared by depositing lithium on the substrate or by compressing a lithium foil thereon.

20. A lithium secondary battery comprising
a negative electrode according to claim 1; and
a positive electrode comprising at least one positive active material selected from the group consisting of a lithium-included metal oxide, a lithium-included chalcogenide compound, a sulfur-based material, and a conductive polymer.

21. The lithium secondary battery according to claim 20, wherein the lithium-included metal oxide or lithium-included chalcogenide compound is at least one selected from the group consisting of compounds represented by the formulas (1) to (13):



wherein

$$0.9 \leq x \leq 1.1, 0 \leq y \leq 0.5, 0 \leq z \leq 0.5, 0 \leq \alpha \leq 2;$$

M is at least one selected from the group consisting of Al, Ni, Co, Mn, Cr, Fe, Mg, Sr, V, and rare earth elements;

A is selected from the group consisting of O, F, S, and P; and

X is selected from the group consisting of F, S, and P.

22. The lithium secondary battery according to claim 20, wherein the sulfur based material is selected from the group consisting of elemental sulfur, Li_2S_n ($n \geq 1$), or Li_2S_n ($n \geq 1$) dissolved in a catholyte, an organo sulfur compound, and a carbon-sulfur polymer $(\text{C}_2\text{S}_x)_n$ (wherein $x = 2.5$ to 50 , $n \geq 2$).

23. The lithium secondary battery according to claim 20, further comprising a separator interposed between the positive electrode and the negative electrode, wherein the separator is selected from the group consisting of a polyethylene, polypropylene, or polyvinylidene fluoride separator, a polyethylene/polypropylene two-layered separator, a polyethylene/polypropylene/polyethylene three-layered separator, and a polypropylene/polyethylene/polypropylene three-layered separator.

24. The lithium secondary battery according to claim 20, further comprising an electrolyte, wherein the electrolyte is a non-aqueous electrolyte or a solid electrolyte.

25. The lithium secondary battery according to claim 20, wherein the negative electrode comprises:

a substrate having a mean roughness of 30 to 4000 Å; and

a lithium layer coated on the substrate.

26. The lithium secondary battery according to claim 25, wherein the mean roughness of the substrate is 30 to 1500 Å.

27. The lithium secondary battery according to claim 26, wherein the mean roughness of the substrate is 30 to 500 Å.

28. The lithium secondary battery according to claim 27, wherein the mean

roughness of the substrate is 30 to 100 Å.

29. The lithium secondary battery according to claim 25, wherein the substrate for the negative electrode consists of a conductive material.

30. The lithium secondary battery according to claim 25, wherein the substrate is selected from the group consisting of a metal foil, a metal film, a conductive polymer film, a polymer film deposited with metal, and a polymer film incorporated with a conductive agent.

31. The lithium secondary battery according to claim 30, wherein the metal is copper or nickel.

32. The lithium secondary battery according to claim 30, wherein the conductive polymer film is at least one selected from the group consisting of polyacetylene, polypyrrole, polyaniline, polythiophene, poly(p-phenylene), poly(phenylene vinylene), polyazulene, polyperinaphthalene, polyacene, and polynaphthalene-2,6-diyl.

33. The lithium secondary battery according to claim 30, wherein the polymer film deposited with metal is a polymer film on which a metal is deposited, and wherein the polymer film is at least one selected from the group consisting of polyester, polyolefin, polyamide, poly(vinylidene fluoride), poly(tetrafluoro ethylene), polystyrene, poly(acrylonitrile), poly(vinyl chloride), polycarbonate, polyacrylate, and a copolymer or a mixture thereof.

34. The lithium secondary battery according to claim 30, wherein the polymer film incorporated with the conductive agent is a polymer film having a conductive agent dispersed therein, and wherein the polymer film is at least one selected from the group consisting of polyester, polyolefin, polyamide, poly(vinylidene fluoride), poly(tetrafluoro ethylene), polystyrene, poly(acrylonitrile), poly(vinyl chloride), polycarbonate, polyacrylate, and a copolymer or a mixture thereof.

35. The lithium secondary battery according to claim 34, wherein the conductive agent is selected from the group consisting of a conductive metal oxide, a metal, and a carbonaceous material.

36. The lithium secondary battery according to claim 35, wherein the conductive agent is selected from the group consisting of tin oxide, tin phosphate (SnPO_4), titanium oxide, a perovskite material, tin, copper, nickel, graphite, and carbon black.

37. The lithium secondary battery according to claim 33, wherein the mean roughness of polymer film deposited with metal is 30 to 3000 Å.

38. The lithium secondary battery according to claim 37, wherein the mean roughness of the polymer film deposited with metal is 30 to 1500 Å.

39. The lithium secondary battery according to claim 38, wherein the mean roughness of the polymer film deposited with metal is 30 to 500 Å.

40. The lithium secondary battery according to claim 39, wherein the mean roughness of the polymer film deposited with metal is 30 to 100 Å.

41. The lithium secondary battery according to claim 25, wherein the lithium layer is prepared by depositing lithium on the substrate or by compressing a lithium foil thereon.

42. The negative electrode of claim 11, wherein the polyester is one of: poly(ethylene terephthalate) (PET), poly(butylene terephthalate) (PBT), a copolymer thereof and a mixture thereof.

43. The negative electrode of claim 11, wherein the polyolefin is one of: polyethylene, polypropylene, a copolymer thereof and a mixture thereof.

44. The negative electrode of claim 11, wherein the polyamide is one of: nylon, a copolymer thereof and a mixture thereof

45. The negative electrode according to claim 7, wherein the polymer film deposited with metal is a polymer film on which a metal is deposited, and wherein the polymer film is at least one selected from the group consisting of: poly(vinylidene fluoride), poly(tetrafluoro ethylene), polystyrene, poly(acrylonitrile), poly(vinyl chloride), a copolymer thereof and a mixture thereof.

46. The negative electrode of claim 11, wherein the polyacrylate is one of: poly(methyl methacrylate), and a copolymer or a mixture thereof.

47. The negative electrode of claim 10, wherein the polyester is one of: poly(ethylene terephthalate) (PET), poly(butylene terephthalate) (PBT), a copolymer thereof and a mixture thereof.

48. The negative electrode of claim 10, wherein the polyolefin is one of: polyethylene, polypropylene, a copolymer thereof and a mixture thereof.

49. The negative electrode of claim 10, wherein the polyamide is one of: nylon, a copolymer thereof and a mixture thereof

50. The negative electrode for the lithium secondary battery according to claim 7, wherein the polymer film incorporated with the conductive agent is a polymer film having a conductive agent dispersed therein, and wherein the polymer film is at least one selected from the group consisting of: poly(vinylidene fluoride), poly(tetrafluoro ethylene), polystyrene, poly(acrylonitrile), poly(vinyl chloride), a copolymer thereof and a mixture thereof.

51. The negative electrode of claim 10, wherein the polyacrylate is one of: poly(methyl methacrylate), and a copolymer or a mixture thereof.

52. A negative electrode for a lithium secondary battery comprising:
a polymer film deposited with metal; and
a lithium layer coated on the polymer film.

53. The negative electrode according to claim 52, wherein the mean roughness of the substrate is 30 to 3000 Å.

54. The negative electrode according to claim 53, wherein the mean roughness of the substrate is 30 to 1500 Å.

55. The negative electrode according to claim 54, wherein the mean roughness of the substrate is 30 to 500 Å.

56. The negative electrode according to claim 55, wherein the mean roughness of the substrate is 30 to 100 Å.

57. The negative electrode according to claim 52, wherein the polymer film deposited with metal is a polymer film on which a metal is deposited, and wherein the polymer film is at least one selected from the group consisting of polyester, polyolefin, polyamide, polycarbonate, polyacrylate, and a copolymer or a mixture thereof.

58. The negative electrode of claim 57, wherein the polyester is one of: poly(ethylene terephthalate) (PET), poly(butylene terephthalate) (PBT), a copolymer thereof and a mixture thereof.

59. The negative electrode of claim 57, wherein the polyolefin is one of: polyethylene, polypropylene, a copolymer thereof and a mixture thereof.

60. The negative electrode of claim 57, wherein the polyamide is one of: nylon, a copolymer thereof and a mixture thereof

61. The negative electrode according to claim 52, wherein the polymer film deposited with metal is a polymer film on which a metal is deposited, and wherein the polymer film is at least one selected from the group consisting of: poly(vinylidene fluoride), poly(tetrafluoro ethylene), polystyrene, poly(acrylonitrile), poly(vinyl chloride), a copolymer thereof and a mixture thereof.

62. The negative electrode of claim 57, wherein the polyacrylate is one of: poly(methyl methacrylate), and a copolymer or a mixture thereof.